GEL-IN-MATRIX CONTAINING A FRACTURED HYDROGEL

This application is a continuation of application Ser. No. 600,272, filed Sep. 26, 1990, now abandoned which, is a continuation of application Ser. No. 115,680, filed Oct. 30, 1987, now abandoned.

BACKGROUND OF THE INVENTION

The invention relates to a three dimensional matrix, such as porous foam, which has within its porous structure a mechanically-fractured hydrogel that contains a network of fracture channels. More particularly, the gel-in-matrix may contain a mechanically-fractured hydrogel that has been partially dewatered to create the porous network of fracture channels.

Gel-forming materials such as hydrogels are well known for their usefulness in electrophoretic and chromatographic procedures, as well as for the immobilization of biologically active materials. The microporosity of hydrogels allows their use in the electrophoretic separation of macromolecular fragments according to size via their diffusion at different rates through the gel. The permeability of these hydrogels, however, is limited by the small size of the pores in the gel and by the diffusion-controlled flow in such pores. Gel porosity may be enhanced to a limited degree by using low concentrations of the gel forming material, but the resultant gels are ordinarily fragile and difficult to handle.

U.S. Pat. No. 4,452,892 issued to Rosevear concerns the immobilization of biologically active components in a gel-forming material which is retained on or in a support medium like woven cloth or thin section sponge. The support material serves to inhibit sedimentation of the biologically active components prior to and during gelling and to reinforce the gel composite that is formed.

It is evident that the permeability of the gel employed in such gel composites is a controlling factor in the reactivity or activity of the gel composite, when the latter is exposed to a fluid containing species that can interact with the biologically active components immobilized within the gel.

British Patent No. 1,570,485 issued to Winson and European Patent No. 41,934 issued to Laszlo do not concern immobilization of biologically active materials but instead describe foam structures containing polymer particles that are gel-forming and that are capable of imbibing large amounts of water. The foam structure provides a support medium for the gel-forming particles, which only occupy a small fraction of the foam's void volume and which are typically introduced into the foam structure via dry blending with foam pieces or via organic solvent carriers.

These gel composites suffer from drawbacks that limit their utility. The polymer particles may become dislodged from the foam structure unless anchored with a binder material. The difficulty of ensuring uniform distribution of the polymer particles throughout the open cell foam structure places constraints on the maximum usable size of polymer particles and on minimum usable pore size in the foam structure.

The present invention concerns a gel-containing matrix structure that not only possesses the advantages realized by the prior art gel composites but also avoids many of their drawbacks.

SUMMARY OF THE INVENTION

The article of manufacture of the present invention is characterized by a three dimensional porous matrix having within its matrix structure a mechanically-fractured hydrogel containing a network of fracture channels. The mechanically-fractured hydrogel is preferably a partially-dewatered hydrogel, which has been dewatered in situ via mechanical means to yield the network of fracture channels.

The three dimensional porous matrix may be either rigid or flexible. The matrix is preferably a reticulated open-cell flexible foam.

The hydrogel is preferably a polysaccharide hydrogel and is more preferably selected from the group of alginate, carrageenan, agar and agarose gels.

The hydrogel fracture channels create a relatively porous structure for the gel-in-matrix of this invention, allowing relatively free ingress and egress of liquid media that may be contacted with the gel-in-matrix. The porosity, or void volume, of the gel-in-matrix may range from about 10 to 90%, but is preferably 50 to 90%. The fracture channels in the gel desirably have a mean characteristic dimension i.e., corresponding to a pore diameter, of from 0.1 μm to 1000 μm, preferably in the range of 1–100 μm.

The gel-in-matrix of this invention is preferably a mechanically-fractured hydrogel whose fracture channels have been created during partial dewatering of the gel in situ, by compression and decompression of the hydrogel while in the matrix. The dewatered hydrogel in the gel-in-matrix typically contains from 10 to 90% of the original gel weight prior to dewatering.

The hydrogel in the gel-in-matrix may alternatively be a mechanically-fractured gel that has been obtained via freezing and thawing of the gel in situ, within the matrix, which ordinarily results in the gel being partially dewatered. Other mechanical means for creating fracture channels within the hydrogel may also be used, as described further below, with or without concomitant partial dewatering.

The gel-in-matrix of this invention may be used in chromatographic applications. Another field of utility is immobilization or entrapment of biologically active materials within the gel used to prepare the gel-in-matrix, since the porosity created by the fracture channels facilitates efficient, intimate contact of a liquid medium with the biologically active components within the gel-in-matrix.

DETAILED DESCRIPTION

The gels-in-matrix of this invention exhibit unusually good apparent gel strength because of the support and protection against gel disruption or collapse provided by the matrix structure. Fragile gels that cannot easily be handled in conventional slab or bead form can be employed as the hydrogel in a gel-in-matrix. Such gels-in-matrix can be manipulated or used in applications that would ordinarily be precluded from consideration due to the inherent weakness of the hydrogel.

The gels-in-matrix of this invention are also characterized by having both high porosity and large pores, or fracture channels. The network of fracture channels in the hydrogel of the gel-in-matrix creates good hydraulic permeability, i.e., its porosity and pore sizing are such as to allow aqueous media to flow freely through the gel-in-matrix. Porosity of the gel-in-matrix may range from about 10 to 90%, but is preferably about 50 to 90%.